THE PROGRESS OF MARINE BIOLOGY.[1]

OR some few years past the advances made by oceanography have been very marked, thanks to the rivalry which has grown up between different peoples. The English, the Americans, the Germans, the Belgians, the Scandinavians, and the Russians have made great efforts in this direction, while France, Italy, Austria and Portugal have not remained outside of the movement. Consequently this science in its principal features is already pretty well known.

But oceanography touches many departments of science, and amongst them marine biology is for the moment the least advanced, because it requires researches of a particularly difficult kind. It is to it that I have more particularly devoted my attention, and it is of it that I propose to speak this evening.

From the reports of many important expeditions, you are already well aware how universally distributed life is, even in the greatest depths of the sea; nevertheless, the means employed in this kind of investigation have been, as a rule, too primitive to furnish very complete results. In my own personal oceanographical work I have, for long, employed new means and methods, which attract different groups of marine animals, each according to its own characteristic instincts, and I have been able in this way to add to our knowledge of zoology.

It is not, however, enough to collect. We must also endeavour to penetrate the mystery of the laws which regulate life in the medium of the sea, so different in almost all respects from that of the air. For this the oceanographer requires the collaboration of the biologist and the physiologist.

Not unfrequently unexpected circumstances open to the observer new horizons, to be afterwards explored by science. It is thus that, finding myself among the islands of the Azores, to which my oceanographical researches have frequently conducted me, I assisted at the capture of a *cachalot*, or sperm whale, by the whalers of the country; simple peasants, who launch their well appointed whale boats the moment that the appearance of a fish is signalled by the look-out man, who is continually stationed on a little hill in their neighbourhood, and I have seen how these mammals go to the intermediate depths of the ocean in search of the great cephalopods which form their exclusive nourishment. When the *cachalot* in question came to endure the convulsions of death, its stomach rejected enormous fragments of the prey which it had captured during its last sounding.

It is in this way that I have recognised the existence of a fauna remarkable for the size and the number of its components, relegated to the large space which separates the surface from the great depths, but the organisation of which prevents its rising to the regions illuminated by the light of the sun, and probably also its descending to the bottom, when this lies beyond a certain depth.

What other groups of living animals inhabit these regions? We know nothing of them yet, but we may believe that they abound, because beings as powerful as these cephalopods require much nourishment.

So soon as I understood the importance of researches capable of throwing light on the life which exists in regions inaccessible to our ordinary means, I established on board of my ship all the equipments of a whaler, namely, three whale boats, each carrying a harpoon gun, several harpoons, a lance and a thousand metres of line, and I added to the complement of my ship an experienced Scottish whaler. The results of this organisation have left nothing to be desired. The cetaceans obtained already form an interesting collection, and their stomachs were abundantly furnished with these cephalopods.

In the Mediterranean, where previously the cetaceans had never been hunted, I have taken several individuals of the species *Grampus griseus, Orca gladiator, Globiceps melas,* and I lost a *Balenoptera musculus.* In the Atlantic Ocean I have taken several Globiceps and Grampus, as well as a very rare specimen of dolphin, *Steno rostratus.* I have also lost a cetacean of moderate size but of undetermined species.

The attack of cetaceans, especially when they are large, causes the harpooneering novice an emotion which diminishes his *adresse*; and even for a good shot the use of the harpoon gun is very difficult when there is the least motion of the sea. A school of animals has been sighted. Their presence has been revealed by their blowing, or by the regular reappearance of their backs at a greater or less distance from the ship, which is then steered towards them. If the animals are of the species already mentioned, the movement of the propeller does not trouble them; on the contrary, they may almost always be seen to come and take up station near the stern as if retained by curiosity. But some species, and among them the *cachalot,* seem to distrust this neighbourhood, and care must be taken that they do not hear even the too marked sound of oars; indeed, in such cases it is preferable to use paddles rather than oars.

The animals have found in the depth a favourable hunting ground, and they do not leave it. They sound to this depth during a time which varies from ten to forty-five minutes, according to the species, and come to the surface again to breathe during four or five minutes. These alternations repeat themselves, sometimes for several hours consecutively, almost on the same spot, with occasional pauses, which seem to be those of repose. It is when the cetaceans appear in this way at the surface that the nearest whaleboat should make every endeavour to come up with them before they again disappear, and so soon as one of them gives a sufficiently good presentation of the part of its body near the head, the harpooneer fires his shot. But this critical moment seldom arrives until after several hours of pursuit, even when the animals are full of confidence and allow the whalers to get well in amongst them. Most frequently, and in the most favourable circumstances, it happens that during the three or four seconds which the emergence of the animal at each of his eight or ten respirations lasts, the presentation is bad, or the movement of the sea has destroyed the aim; it is then necessary to wait until after the next sound.

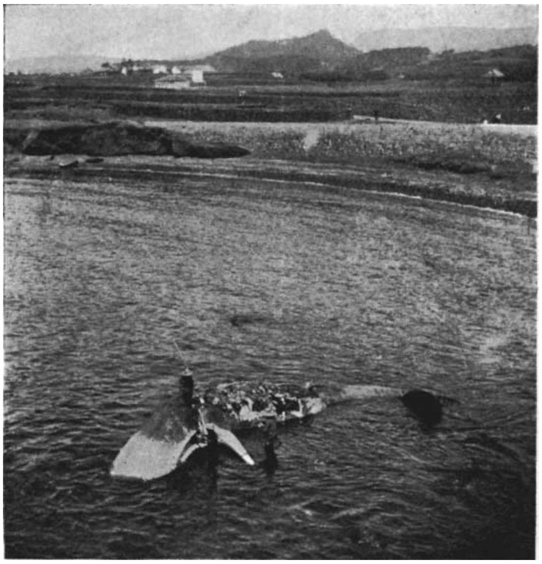

Fig. 1.—Breaking up a Sperm Whale.

If the animals sighted pursue a fixed route with any speed, it is useless to attempt the attack; it is impossible to come up with them because they are then on passage. Once I followed a large Balenoptera for six hours with my ship. He travelled about thirty miles in an absolutely straight line, which shows that the marine animals possess a sense of orientation more remarkable than that of the migratory birds, because these can always see the ground above which they travel.

At last, close to the boat, a powerful blow like a jet of steam comes out of the water; the back of the animal emerges immediately afterwards; in the movement necessary to recover the horizontal position of its head, the dorsal fin appears and finally the lumbar region, which is much curved by the action of the tail, which determines the descent. It now proceeds for several lengths, hardly submerged, whilst the steersman, who can see the lighter-coloured portions of this immense body, and sometimes certain pools caused by the motion of the dorsal fin, steers the boat, driven by all the force of its crew, so as to cross the route of the cetacean. A fresh blow cuts the water, a black back presents itself at a distance of five or six metres, the shot is fired, and the eye can follow the harpoon with the attached line.

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[1] A Discourse delivered at the Royal Institution on Friday, May 27, by H.S.H. Albert I., Prince of Monaco.

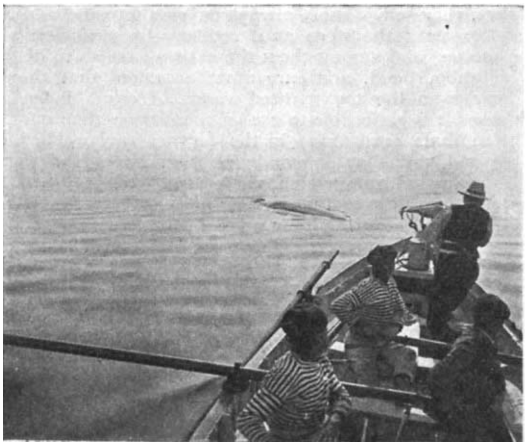

FIG. 2.—Harpooning a Whale.

But at the first moment there is nothing to show that the animal has been touched. In a body of such size the arrival of sensation in the brain and the transmission of the will to the periphery require a sensible time. The success of the harpooneer is indicated by the rapid running out of the line, which very soon produces heat and a dense smoke in the bollard, round which a turn is taken in order to allow the harpooneer to regulate the run of the line according to the velocity of the cetacean and the direction which it follows. This is a very delicate moment for the safety of the whale-boat; nobody moves, and the turns of the line, carefully coiled in a receptacle, run out without a check. A second boat approaches in order to take the end of this line, when it is apparent that the thousand metres in the first boat will not be sufficient, and to add it to his own line. The running out is continued from this boat, and sometimes the three whale boats are rapidly cleared of their lines. But, with the friction which such a length of line offers, and to which the resistance of the boats towed has to be added, the cetacean reduces its speed very sensibly, so that there is no difficulty in maintaining it. Little by little the line is got back into the boats, and after various alternations the weakened animal advances more and more slowly, and close to the surface, where it is obliged to breathe more and more frequently.

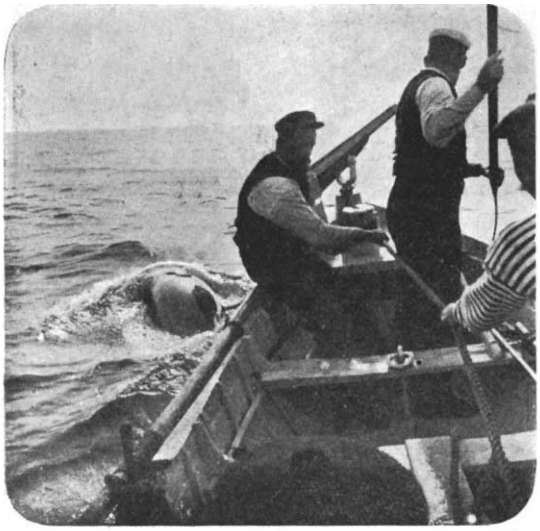

FIG. 3.—Towed by a Grampus.

Often many hours have passed before the favourable moment arrives for despatching the unfortunate victim and terminating the drama, and this is accompanied by the most serious circumstances of the whole enterprise. The exhausted animal stretches itself on the surface, almost motionless before the boat, where the harpooneer now holds a lance which has a considerable length, because it must pass through the whole thickness of the blubber and of the muscles before it reaches the vital organs. He approaches the animal by its side, so as not to be struck by the tail, which may be thrown violently into the air so soon as the cetacean receives this new wound; but it is not always possible to avoid being struck by a fin, and especially in the case of large animals, this may wreck a boat. In spite of all the skill of the crew an accident of this kind may occur, and I could relate cases mentioned by various captains in which *cachalots,* old and solitary individuals, have seized and crushed between their jaws the boats which have attacked them. It has even been reported that two ships have been sunk by such animals in their fury, their enormous wedge-shaped head becoming in these circumstances a formidable ram.

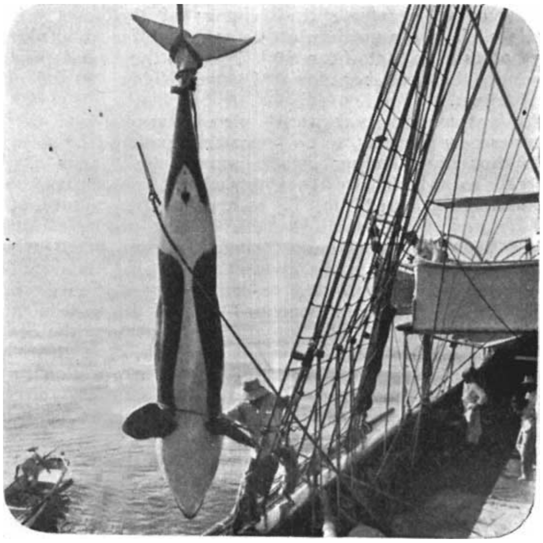

FIG. 4.—Hauling an Orca on board.

When a cetacean of any size has been several times pierced, the red pool which spreads far over the sea gives the idea of great carnage. In fact the cetaceans contain a very large amount of blood, and before the last hour, when they lose it in torrents, they have already left behind them a red track of eight or ten miles in length over which they have towed the boats.

I have said that apart from the interest which each species of cetacean offers of itself (and it appears that some of them are hardly known at all), it is in the first place the contents of their stomachs which occupy us. The species which I have taken differ much in the nature of their prey, and their mouths are armed correspondingly. The *right whale* is content to absorb the *plankton* composed of extremely small animals, which in some regions form a compact mass, a real cloud; and in order to keep out objects too large to pass down its very small throat, its jaws are furnished with the well known and valuable *whalebone,* which acts as a sieve.

The Grampus, the Globiceps, and the Cachalot penetrate to a depth probably much greater in search of cephalopods, and they possess a dentition specially organised for seizing the gelatinous flesh of the cephalopods. The scars which they bear over the whole of their bodies are evidence of the energy with which their victims defend themselves with their suckers, often armed with formidable talons.

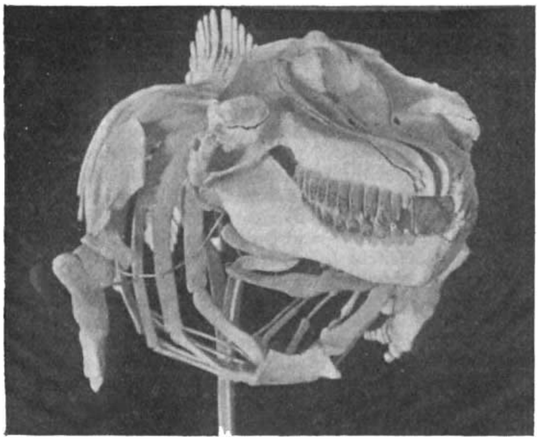

FIG. 5.—Skeleton of an Orca.

The Orca, provided with a more compact dentition, pursues the dolphins, of which it makes scarcely more than three or four mouthfuls, showing thus a remarkable power of digestion.

The dolphins themselves are more eclectic, and I have found in their stomachs several species of fish as well as cephalopods, but in both of them the characteristics special to great depths are wanting.

The principal object which I had in view in capturing the cetaceans, the knowledge of the beings living in the abysses, has been realised by the acquisition of a certain number of new and very rare cephalopods. Some of these are gigantic, and amongst them may be cited *Lepidoteuthis Grimaldii,* one of the most remarkable animals of the sea on account of its considerable size, and also because, though it is a cephalopod, it possesses scales like a fish.

The more we know of marine biology, and the more we learn from it of the links which connect the creatures spread over our planet, of the interpenetration of types, such as that shown by Lepidoteuthis, as well as of the vital force, the great power of reproduction, the number of individuals in certain species, and the high antiquity of other forms, we seem to be justified in imagining that the sea may have been the cradle of organic life when the cooling of the atmosphere determined the precipitation of the waters.

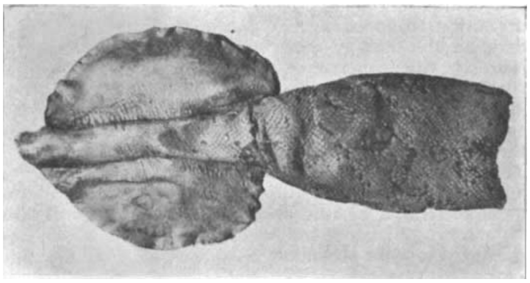

FIG. 6.—Part of the Fin of a Gigantic Cephalopod.

THE ROYAL OBSERVATORY, GREENWICH.

THE report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, was read at the annual visitation of the observatory on Saturday last. Some of the results and observations described in the report are referred to in the subjoined abstract.

The progress made in the observation of the reference stars for the astrographic plates (for which more than 10,000 stars are to be observed, three times above and twice below pole) has been so satisfactory that it is expected that sufficient observations of all the stars will have been secured by the end of 1905, at which date it is proposed to terminate the observations. The catalogue of the astrographic reference stars will thus be completed in nine years, a year earlier than was originally proposed.

After consultation with Prof. Albrecht, it has been arranged to apply the correction for latitude deduced by him from the provisional discussion of the international series of observations to all observations of north polar distance year by year, commencing with 1902, Prof. Albrecht having arranged to communicate his results as soon as practicable after the end of the year. This correction has been applied to all the north polar distances for 1902 and to the planetary observations for 1903, and is now being applied in the star ledgers.

Provision having been made for the comparison between theory and the Greenwich meridian observations of the moon from 1750 to the present time, the discussion of the longitude of the moon 1750–1901, compared with revised tabular places, has been undertaken by Mr. Cowell on a plan devised by him, which enables the complex calculations to be done in a very economical manner, the lunar day being adopted as the unit of time. Mr. Cowell has published explanations of his methods of analysis of the moon's errors, together with some of the results obtained, in the *Monthly Notices* of the Royal Astronomical Society, November, 1903, to May, 1904.

The 28-inch refractor has been used throughout the year for micrometric measurements of double stars. The total number of double stars measured during the year is 512; of these, 178 have their components less than 1″·0 apart, and 85 less than 0″·5. The wider pairs consist of bright stars with faint companions, stars of special interest, and stars from Struve's catalogue which have not been measured within the last thirty years.

The occulting shutter has been used in the photography of Neptune and its satellite with the 26-inch refractor, and a good series of photographs has been obtained during the opposition of 1903–4. During the year the following photographs have been taken:—with the 26-inch refractor, 58 photographs of Neptune and satellite, 22 photographs of 10 double stars, 13 photographs for adjustments; with the 30-inch reflector, 117 photographs of 40 minor planets, 27 photographs on 27 nights of comet *c* 1903, 17 photographs on 12 nights of comet *a* 1904.

The photographs of comets have all been taken with short exposures, usually four on each plate, and are for the purpose of determining positions. Four exposures have also been given on each photograph of a minor planet, the object being to obtain accurate determinations of position on three or four nights for each planet during the opposition. In addition, the following photographs with long exposures have been obtained:—of comet *c* 1903, comet *a* 1904, the great nebula in Andromeda, and the Pleiades.

Considerable progress has been made with the measurement of the long series of photographs of Eros taken during the opposition of 1900–1. The measures have been made with the new micrometer described in a communication to the Royal Astronomical Society on May 13. With the magnification in use the probable error of the bisection of a perfectly defined speck is ±0″·020; the probable accidental error of a single measure of an image of Eros is found to be ±0″·067 on an astrographic plate, and ±0″·049 on a Thompson plate.

Owing to the error inherent in the star-images, the probable error of a position of Eros derived from a number of measures of four images on one plate is not nearly so small as the above measures suggest. Comparison of the positions of Eros for October 26 and 27 with the tabular places of M. Loewy's ephemeris gives a probable error of